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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/764,295
Filing Date: January 23, 2004
Appellant(s): VOLKEL, THOMAS

John P. Musone
For Appellant

EXAMINER'S ANSWER

This is in response to the Appeal Brief filed 23 August 2007 appealing from the Office Action mailed 23 February 2006.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is substantially correct. The Examiner does note that the status of amendments after final indicates that an Advisory Action was mailed on 19 April 2006, while the Advisory Action was actually mailed on 19 May 2006.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

WO 99/60351	LOFALL	11-1999
5,922,963	PIETY ET AL	7-1999
EP 0 908 805 A1	HOTH ET AL	10-1997

(9) Grounds of Rejection

Per the After Final amendment filed April 18, 2006, and entered for the purposes of appeal, the following ground(s) of rejection are applicable to the appealed claims:

Claims 1, 4-8, 10, 13, 15, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over International Application Publication No. 99/60351 to Lofall in view of U.S. Patent No. 5,922,963 to Piety et al. and further in view of European Patent Application Publication No. 0 908 805 to Hoth et al.

Lofall discloses a method for spectral evaluation of a rotating object comprising providing a first operating parameter that is an actual rotational speed value (page

29, lines 4-6 and page 30, lines 18-19), automatically (page 19, lines 17-19) recording a frequency spectrum of the object to be tested by measuring means, wherein the frequency spectrum has first amplitude values which depend on first frequency values (page 26, lines 3-17), automatically using the first frequency values of the frequency spectrum for normalization in relation to the actual rotational speed value (page 30, lines 9-23), automatically forming an alarm curve with second amplitude values which depend on second frequency values (page 30, lines 24-31), automatically using the second frequency values of the alarm curve for normalization in relation to the actual rotational speed value (page 30, line 32 to page 31, line 8), automatically comparing the first amplitude values of the normalized frequency spectrum with the second amplitude values of the normalized alarm curve (page 31, lines 8-10), and using a result of the comparison to evaluate the object to be tested (page 31, lines 10-12).

Lofall discloses that the measuring means are fashioned as vibro-acoustic measuring means (page 6, lines 21-24)

Lofall discloses that the method is used for a spectral evaluation of a machine (page 7, lines 15-18) for monitoring the vibration of vehicle components (page 34, line 1).

As noted above, Lofall teaches many of the features of the claimed invention and while the invention of Lofall does teach the option of including additional operating parameters of current load and temperature values in the vibration analysis (page 30, lines 5-8, page 32, line 27 to page 33, line 19, and page 38, lines 26-29), Lofall

does not explicitly teach changing the second amplitude values of the reference spectrum according to the operating parameters to form an envelope alarm curve.

Piety teaches a method for determining narrowband envelope alarm limits based on machine vibration spectra comprising obtaining sensed vibration amplitude data from a rotating machine (column 1, lines 6-8) in time domain (column 2, lines 27-36), transforming the time domain data into frequency domain data (column 2, lines 36-40) and comparing the frequency domain data to an alarm limit/curve (column 2, lines 40-46). Piety further teaches gathering vibration amplitude data versus frequency from the rotating machine at a second load value different than a first/current load value and adjusting the alarm limit/curve to account for the difference between the first and second load values, functionally as specified by a user, (column 13, lines 5-33), wherein the alarm curve which is adjusted according to the operating parameters form an envelope curve over the frequency spectrum of the object to be tested in a fault free normal condition, wherein an alarm is generated if at least one amplitude value of the frequency spectrum lies outside the envelope curve (column 4, lines 36-38, column 6, lines 36-34 and Figure 4).

It would have been obvious to one having ordinary skill in the art to modify the invention of Lofall to explicitly teach changing the second amplitude values of the reference spectrum according to the operating parameters to form an envelope alarm curve, as taught by Piety, because, as suggested by Piety the combination would have provided an easy and effective method for developing accurate narrowband alarm limits/curves (column 2, lines 15-23) that takes into account the

affect of load differences on the vibration spectrum by adjusting the alarm limit/curve to be specific for each operating load, thereby improving the accuracy of the fault detection by insuring that a false alarm is not detected due to differences in the vibration data caused by load differences (column 13, lines 5-33) as well as allowed a user to clearly view the alarm results to aid in determining the type and severity of a fault (column 1, lines 25-34).

As noted above, the invention of Lofall and Piety teaches many of the features of the claimed invention and while the invention of Lofall and Piety does teach gathering vibration amplitude data versus frequency from the rotating machine at second load, speed, and/or resolution values different than first/current load, speed, and/or resolution values and adjusting the alarm limit/curve to account for the difference between the first and second load, speed, and/or resolution values (Piety; column 13, lines 5-33), the combination does not explicitly indicate that the alarm curve should also be adjusted for temperature.

Hoth teaches a method and apparatus for performing pre-emptive maintenance on operating equipment for the analysis of a rotary machine (column 5, lines 6-10) comprising monitoring vibration data for failure analysis (column 8, lines 12-20) and comparing the vibration data to reference/norm data (column 3, lines 30-36). Hoth further teaches that the amplitude values of the reference/norm data are calculated for specific instances of load and temperature parameters (column 5, lines 17-24 and column 9, lines 27-35).

It would have been obvious to one having ordinary skill in the art to modify the invention of Lofall and Piety to explicitly indicate that the alarm curve should also be adjusted for temperature, as taught by Hoth, because the invention of Lofall and Piety does adjust the alarm curves for load, speed, and resolution and Hoth suggests that temperature is another important parameter that contributes to the accuracy of vibration analysis (column 5, lines 17-24 and column 9, lines 27-35) and therefore, the combination would have improved the analysis method of Lofall and Piety by taking into account a greater amount of operating parameters that contribute to the analysis to insure that a false alarm is not detected due to differences in the vibration data caused by temperature differences.

(10) Response to Argument

With respect to claim 1, Appellant argues:

> Appellant respectfully submits that the Lofall/Piety/Hoth combination fails to describe or suggest the method set forth in claim 1.
>
> Claim 1 in part recites that the operating states of the object to be tested are characterized by a second operating parameter which is proportional to a load of the object to be tested, and are also characterized by a third operating parameter which is proportional to a temperature of the object to be tested. The amplitude values of the alarm curve are changed according to the second operating parameter, and the third operating parameter.
>
> The Office Action correctly acknowledges that the combination of Lofall and Piety fails to describe that the alarm curve is also adjusted based on temperature. The Office Action then cites Hoth as purportedly overcoming the deficiencies of the Lofall/Piety combination. However, Hoth actually teaches away from the structural and/operational relationships recited in claim 1 regarding the utilization of temperature. More particularly, Hoth uses temperature data as a multiplier for adjusting a calculated probability of failure numbers, whereas claim 1 recites temperature as a basis for adjusting an alarm curve. Accordingly, the Lofall/Piety/Hoth combination does not constitute an

appropriate *prima facie* combination for rejecting claim 1 under 35 USC 103(a), and this rejection (as well as the rejection of claims depending from claim 1) should be withdrawn.

The Examiner asserts that Appellant has not particularly pointed to specific sections of Hoth to support the argument that Hoth teaches away from the structural and/or operational relationships recited in claim 1 regarding the utilization of temperature. The Examiner maintains that since the invention of Hoth does not include any language precluding the changing of an amplitude value according to a third operating parameter, which is proportional to a temperature of the object to be tested, and absent any arguments by Appellant clearly pointing out the specific disclosure that teaches away from the proposed combination, Hoth does not constitute a teaching away. As such, the Examiner does not consider Appellant's arguments to be persuasive.

Appellant argues:

Appellant will now discuss an alternative basis as to why the Lofall/Piety/Hoth combination does not constitute an appropriate *prima facie* combination for rejecting claims under 35 USC 103(a). Appellant will discuss below in particular detail the substantial differences in the approach of Hoth compared to the claimed invention. Appellant regrets for the following rather lengthy summary of the process of Hoth. However, it is believed necessary to point out the substantial differences between Hoth and the present invention as to how each very distinctly approaches the relationship between vibration data alarm limits and secondary parameters, such as machine load and temperature.

Hoth describes a complex multi-step method that provides a quantitative prediction of the likelihood of a failure, which Hoth calls a "final failure probability sum." (column 13, line 41) Hoth arrives at that numeric value via a series of learning and then monitoring steps. First, in a learning mode, Hoth teaches the steps of:

- gathering raw vibration amplitude data (RD) over a number of frequency ranges (column 8, lines 31-38)

- using only data which satisfies certain stability requirements, generating twelve hour average vibration frequency values with a 95% statistical confidence level. (column 9, lines 7-19 and colun 10, lines 39-50) for each frequency band and each load range. In this step, Hoth recognizes that there is a relationship between vibration amplitude response and machine load. However, Hoth does <u>not</u> use that relationship for the purpose of adjusting an alarm value, but rather it causes Hoth to establish a plurality frequency bands and load ranges so as to be able to judge the stability of the acquired raw data within a plurality of ranges.

- building an hourly reading (HR) table from raw data each hour and checking to see if a sufficient number of the data points are within the confidence interval for each frequency band and load condition. (column 11, lines 27-42)

- only if the machine is running normally and is stable, entering a monitoring mode. (column 11, fines 42-46)

Once in the monitor mode, the machine is evaluated by comparing hourly average data to the confidence intervals (column 11, lines 49-53) through the following steps:

- hourly data is checked against limits that are based upon the confidence intervals, and if the limits are exceeded, a neural processor subroutine is entered for calculating a failure probability. (column 12, lines 9-32) Note that no limit is changed during this step, or in any step of the process. Each band of hourly data is compared to a respective confidence interval for each vibration band to generate a weighted probability of machine failure. (column 13, lines 1-13)

- applying load to current ratio and differential temperature factors to the weighted probabilities to arrive at a 'final failure probability sum'. (column 13, lines 33-41) In this manner, vibration data exceeding the confidence interval is caused to have varying effects on the final failure probability sum depending upon the load to current ratio and the differential temperature.

Note that the method of Hoth necessitates the processing of multiple sets of data over a number of load ranges. Furthermore, Hoth never adjusts the confidence interval (i.e. alarm curve) in response to load to current ratio or in response to temperature, but rather, Hoth uses these parameters only to adjust the impact of the calculated failure probability values.

In contrast to the method of Hoth, claim 1 of the present invention provides a much simpler method for evaluating an object to be tested. Claim 1 includes the step of "automatically changing ... the alarm curve according to second and third operating parameters." Hoth never changes an alarm curve; rather, Hoth teaches the necessity of splitting the load parameter into a plurality of ranges in order to provide for a degree of stability in the measured amplitude data. The

present invention avoids the necessity of processing multiple sets of data as must be done in the method of Hoth.

The Examiner asserts that, as pointed out in the Final Office action, the proposed combination does not rely on Hoth for the explicit teaching of automatically changing the amplitude values of an alarm curve based on temperature. Instead, the Examiner asserts that the claimed limitation for "automatically changing the second amplitude values of the alarm curve according to a second operating parameter...the second operating parameter which is proportional to a load of the object to be tested" is already taught by the combination of Lofall and Piety and the invention of Hoth is only relied upon to teach the modification of the Lofall/Piety combination to account for temperature.

Particularly, the Examiner asserts that Lofall discloses a method for spectral evaluation of a rotating object comprising providing a first operating parameter that is an actual rotational speed value (page 29, lines 4-6 and page 30, lines 18-19), automatically (page 19, lines 17-19) recording a frequency spectrum of the object to be tested by measuring means, wherein the frequency spectrum has first amplitude values which depend on first frequency values (page 26, lines 3-17), automatically using the first frequency values of the frequency spectrum for normalization in relation to the actual rotational speed value (page 30, lines 9-23), automatically forming an alarm curve with second amplitude values which depend on second frequency values (page 30, lines 24-31), automatically using the second frequency

values of the alarm curve for normalization in relation to the actual rotational speed value (page 30, line 32 to page 31, line 8), automatically comparing the first amplitude values of the normalized frequency spectrum with the second amplitude values of the normalized alarm curve (page 31, lines 8-10), and using a result of the comparison to evaluate the object to be tested (page 31, lines 10-12).

Lofall also teaches the option of including additional operating parameters of current load and temperature values in the vibration analysis (page 30, lines 5-8), specifically:

> The expert system structure, while initially designed to accommodate vibration spectral data, also can accept any numerical value such as temperature, pressure, flow, electrical current, time domain vibration data, phase angles and so forth. (page 30, lines 5-8)

Since Lofall does not explicitly teach adjusting the second amplitude values of the reference spectrum according to the operating parameters to form an envelope alarm curve, the invention of Piety is then included to teach a method for determining narrowband envelope alarm limits based on machine vibration spectra comprising obtaining sensed vibration amplitude data from a rotating machine (column 1, lines 6-8) in time domain (column 2, lines 27-36), transforming the time domain data into frequency domain data (column 2, lines 36-40) and comparing the frequency domain data to an alarm limit/curve (column 2, lines 40-46).

Piety further teaches gathering vibration amplitude data versus frequency from the rotating machine at a second load value different than a first/current load value

and adjusting the alarm limit/curve to account for the difference between the first and second load values, functionally as specified by a user, (column 13, lines 5-33), wherein the alarm curve which is adjusted according to the operating parameters form an envelope curve over the frequency spectrum of the object to be tested in a fault free normal condition, wherein an alarm is generated if at least one amplitude value of the frequency spectrum lies outside the envelope curve (column 4, lines 36-38, column 6, lines 36-34 and Figure 4), specifically:

> These envelope functions define vibration amplitude limits above which the machine's vibration levels are considered abnormal. (column 4, lines 36-38)

> the processor 38 constructs a limit envelope from the measured spectrum. Since the measured data in this situation is the initial spectrum, and no reference spectrum exists for this machine, the profiler process is invoked to generate an alarm limit envelope. The measured spectrum used to construct the envelope consists of a number of data points, each point representing a vibration level at a particular vibration frequency. (column 6, lines 36-34)

> In a preferred embodiment of the invention, different envelopes can be constructed for the same measurement point/analysis group if the operational parameters of the machine vary significantly. For example, if a group of similar machines is found that commonly runs at 50% load, 75% load, and 100% load, then separate statistical spectra can be constructed so that each set of operational parameters has its own alarm limit envelope. Differences in machine speed and data resolution are also considered in this manner when constructing envelopes. The result is a three-dimensional coverage cube, as shown in FIG. 7, which contains all of the alarm limit envelopes that are applicable for the different operational parameters of a given measurement point and analysis group. The three axes of the cube represent machine speed, data resolution, and machine load. A single set of speed, resolution, and load indices, indicated by C in FIG. 7 represent a certain envelope that was constructed using only data that was taken from a machine when it was operating with those specific parameters. The user may define break-points on the three axis so that the different points on each scale represent what correlates to shifts in operational parameters that could easily result in the machine exhibiting different vibration characteristics. For constant-

> speed/constant-load machinery where data of the same number of resolution lines have always been measured, this technique would find data for only one set of speed, resolution, and load criteria As a result, only one envelope would be created, and the cube of FIG. 7 would have only one entry of significance. (column 13, lines 5-33).

As can be seen by the cited sections above, the combination of Lofall and Piety already teaches automatically changing the values of an alarm curve based on load. This position is not disputed by Appellant as Appellant never argues the Lofall/Piety combination, but instead only argues the modification of the Lofall/Piety combination by Hoth.

As the Lofall/Piety combination already teaches automatically changing the values of an alarm curve based on load, the invention of Hoth is then included to teach the desirability to account for temperature by teaching that the amplitude values of reference/norm data are calculated for specific instance of load and temperature parameters thereby teaching that, in addition to the adjustment taught by the combination of Lofall and Piety, the temperature is also an important factor that needs to be considered. Specifically, Hoth teaches that the amplitude values of the reference/norm data are calculated for specific instances of load and temperature parameters (column 3, lines 22-30, column 5, lines 17-24 and column 9, lines 27-35):

> During the hourly calculation operation, dependent norms in the form of average value correlations are obtained for each vibration frequency band with

> respect to temperature and load. Independent norms are also obtained with respect to the ambient to unit temperature difference and the electrical current to load ratio. The intervals of the data acquisition during [t]he monitor mode are identical to the periodic data intervals in the learn mode described above. (column 3, lines 22-30)
>
> The operating parameters of the operating equipment 12-1 are sensed by a number of sensors 14-1 which may include a vibration sensor, a sensor for determining the machine load, a sensor for sensing the machine temperature, a sensor for sensing the electrical current being drawn by the operating equipment, and a sensor for sensing the ambient temperature. (column 5, lines 17-24)
>
> An additional task for the HCR of Fig. 6 is to calculate certain parametric relationships such as the load to current ratio LC and the ambient to unit temperature difference (T u - T A = TL). The HCR also classifies RD data into load types, which allows all other data to be correlated to the load condition that was present during data acquisition. It will be appreciated that each load condition produces a different set of parametric norms. (column 9, lines 27-35)

The Examiner therefore maintains that the combination of Lofall, Piety, and Hoth meets the claimed limitations for "automatically changing the second amplitude values of the alarm curve according to a second operating parameter...the second operating parameter which is proportional to a load of the object to be tested" and "a third operating parameter which is proportional to a temperature of the object to be tested...the second amplitude values of the alarm curve which is changed according to...the third operating parameter" with the Lofall/Piety combination teaching automatically changing the second amplitude values of the alarm curve according to a second operating parameter which is proportional to a load of the object to be tested and the invention of Hoth teaching that temperature, in addition to load, should be accounted for when generating alarms/norms for analysis.

The Examiner also maintains that it would have been obvious to one having ordinary skill in the art to modify the invention of Lofall and Piety to explicitly indicate that the alarm curve should also be adjusted for temperature, as taught by Hoth, because the invention of Lofall and Piety does adjust the alarm curves for load, speed, and resolution and Hoth suggests that temperature is another important parameter that contributes to the accuracy of vibration analysis (column 3, lines 22-30, column 5, lines 17-24 and column 9, lines 27-35) and therefore, the combination would have improved the analysis method of Lofall and Piety by taking into account a greater amount of operating parameters that contribute to the analysis to insure that a false alarm is not detected due to differences in the vibration data caused by temperature differences.

The Examiner again draws Appellants attention to column 3, lines 22-30 of Hoth which states:

> During the hourly calculation operation, dependent norms in the form of average value correlations are obtained for each vibration frequency band with respect to temperature and load. Independent norms are also obtained with respect to the ambient to unit temperature difference and the electrical current to load ratio. The intervals of the data acquisition during [t]he monitor mode are identical to the periodic data intervals in the learn mode described above.

The Examiner asserts that this section of Hoth clearly lends to the proposed combination of modifying the Lofall/Piety combination, which already teaches automatically changing the second amplitude values of the alarm curve according to a second operating parameter which is proportional to a load of the object to be

tested, since column 3, lines 22-30 of Hoth not only teaches that temperature is an important parameter that contributes to the accuracy of vibration analysis, but also specifically refers to both load and temperature as important parameters that contribute to the accuracy of vibration analysis. Therefore, one having ordinary skill in the art would clearly recognize that, given a teaching of adjusting alarm curves due to load, adjusting for temperature is an obvious modification. As such, since the invention of Lofall and Piety adjusts the alarm curves for load, speed, and resolution and Hoth suggests that temperature, in addition to load, is another important parameter that contributes to the accuracy of vibration analysis (column 3, lines 22-30, column 5, lines 17-24 and column 9, lines 27-35), the combination would have adjusted the amplitude values of the alarm curve for temperature thereby improving the analysis method of Lofall and Piety by taking into account a greater amount of operating parameters that contribute to the analysis to insure that a false alarm is not detected due to differences in the vibration data caused by temperature differences.

Appellant argues:

Appellant respectfully notes that the CAFC decision in *In re Kumar*, 418 F.3d 1361, 76 USPQ2d 1048, 1053 (Fed. Cir. 2005) states 'To render a later invention unpatentable for obviousness, the prior art must enable the later invention.' The Hoth reference fails to enable the present invention since it fails to teach any method for automatically changing the amplitude values of an alarm curve. The use of temperature data, as actually described by Hoth, would not enable the claimed invention. Appellant believes it is error for the Examiner to simply say that since Hoth uses temperature (albeit in a completely different manner as in the claimed invention), then Hoth remedies the shortcomings of

> Lofall and Piety. This assertion is not sufficient in view that the specific approach described by Hoth cannot be disregarded since such an approach would make the claimed invention (and the resulting prior art combination) inoperable for its intended purpose. See *In re Gordon*, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (finding no suggestion to modify a prior art device where the modification would render the device inoperable for its intended purpose). One of ordinary skill in the art would not have been motivated to combine the vastly different approach described by Hoth with the Lofall/Piety combination. Thus, on this alternative basis, appellant submits that the combination of Lofall/Piety/Hoth does not support the rejections under 35 USC 103.
>
> In view of the foregoing remarks, It Is respectfully submitted that neither Lofall, Piety, nor Hoth, singly or in combination, teach or suggest the structural and/or operational relationships set forth in claim 1. Accordingly, the Lofall/Piety/Hoth combination falls to render claim 1 unpatentable under the §103 statutory requirements and this rejection should be withdrawn. Since dependent claims 4-8, 10, 13, and 15 include the structural and/or operational relationships respectively recited in claim 1, it is also respectfully submitted that the Lofall/Piety/Hoth combination also falls to render unpatentable claims 4-8, 10, 13, and 15. Accordingly, the rejection of claims depending from claim 1, should also be withdrawn.

The Examiner asserts that, as noted above, the proposed combination of Hoth with the invention of Lofall and Piety, has been fully addressed. The Examiner does note that Appellant's argument that Hoth "would make the claimed invention (and the resulting prior art combination) inoperable for its intended purpose" is not considered to be persuasive as the proposed combination is only to modify the combination of Lofall and Piety to adjust the amplitude values of the alarm curve to account for temperature. Such a modification would not render the Lofall/Piety combination inoperative as the resulting operation of comparing amplitude values of the frequency spectrum to the amplitude values of the alarm curve in order to evaluate an object, would still be able to be performed.

Appellant argues:

> Independent claim 18 is directed to a method for evaluating a rotating machine. Claim 18 in part recites adjusting the alarm curve to account for a difference between first and second temperatures. As discussed above, Hoth not only fails to teach the foregoing operational relationship but actually teaches away from it, or, in the alternative, Hoth fails to enable the claimed invention. Accordingly, the Lofall/Piety/Hoth combination does not constitute an appropriate prima facie combination for rejecting claim 18 under 35 USC 103(a), and this rejection should be similarly withdrawn.

The Examiner maintains that, as detailed above with respect to claim 1, the combination of Lofall, Piety, and Hoth does teach "adjusting the alarm curve to account for differences between first and second temperatures" as the combination of Lofall and Piety teaches gathering vibration amplitude data versus frequency from the rotating machine at a second load value different than a first/current load value and adjusting the alarm limit/curve to account for the difference between the first and second load values (Piety; column 13, lines 5-33), Hoth teaches that both load and temperature are important parameters that contribute to the accuracy of vibration analysis (column 3, lines 22-30, column 5, lines 17-24 and column 9, lines 27-35), and one having ordinary skill in the art would clearly recognize that, given a teaching of adjusting alarm curves due to load, adjusting for temperature is an obvious modification because the combination would have adjusted the amplitude values of the alarm curve for temperature and improved the analysis method of Lofall and Piety by taking into account a greater amount of operating parameters that contribute to the analysis to insure that a false alarm is not detected due to differences in the vibration data caused by temperature differences.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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